

Photonic Signal Processing for Antennas

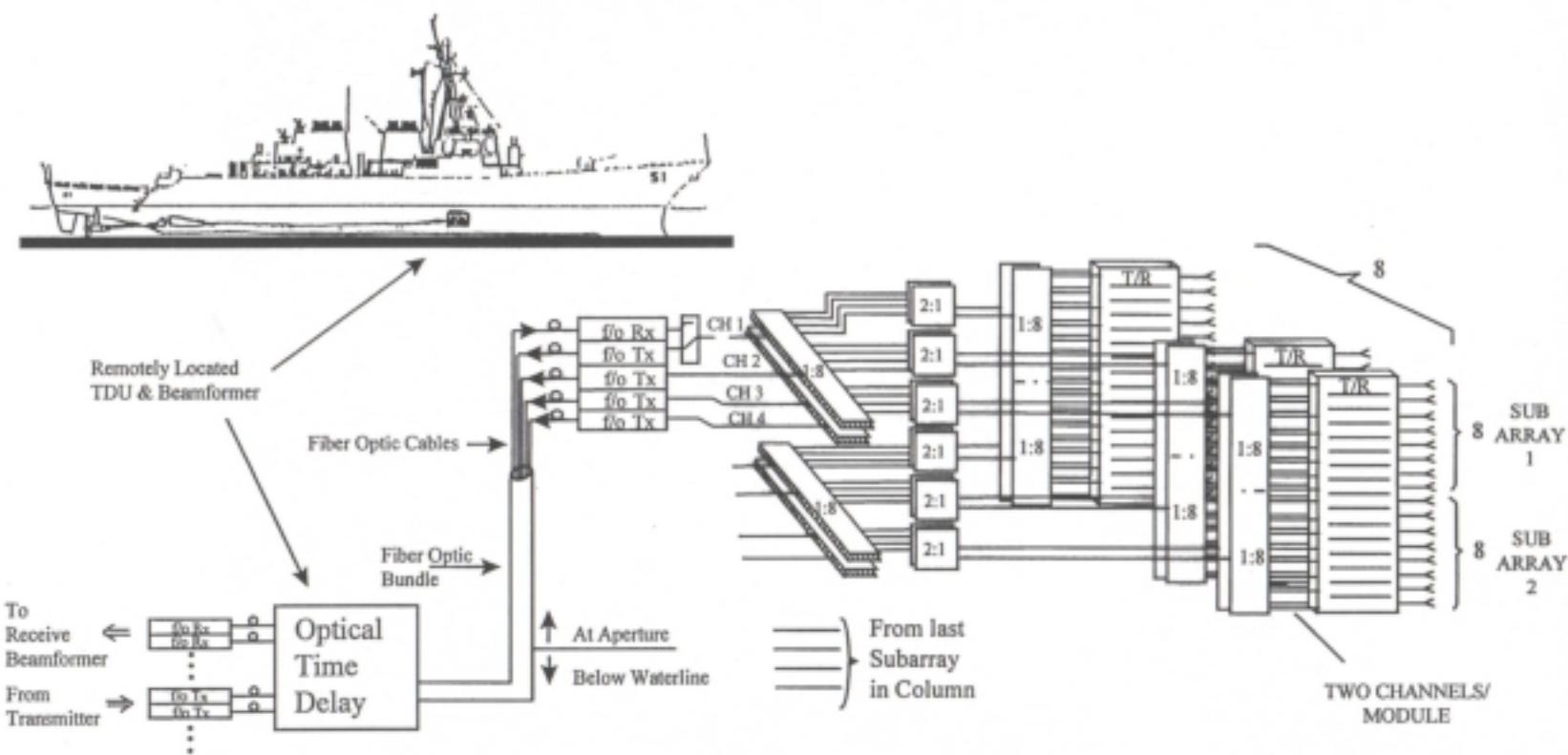
Nabeel A. Riza

Photonic Information Processing Systems (PIPS) Laboratory
The School of Optics

and Center for Research and Education in Optics and Lasers (CREOL)
University of Central Florida
Orlando, FL

DARPA AOSP Study Group
December 6, 2000

Implementation of the Photonic Beamformer for the Dual-Band Lockheed Martin - GES Aegis Radar



The LM-GES AEGIS Class Phased Array Radar-Typical Design Numbers

-- Near 2300 Independent Time Delay Units



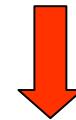
Need lots of 2x2 Switches
-- Need a low cost approach

-- Near 7 bits of Binary Switched Time Delay Control

-- Shipboard Platform



Beamformer Size, Weight, Volume NOT as critical -ultra-compact design not required

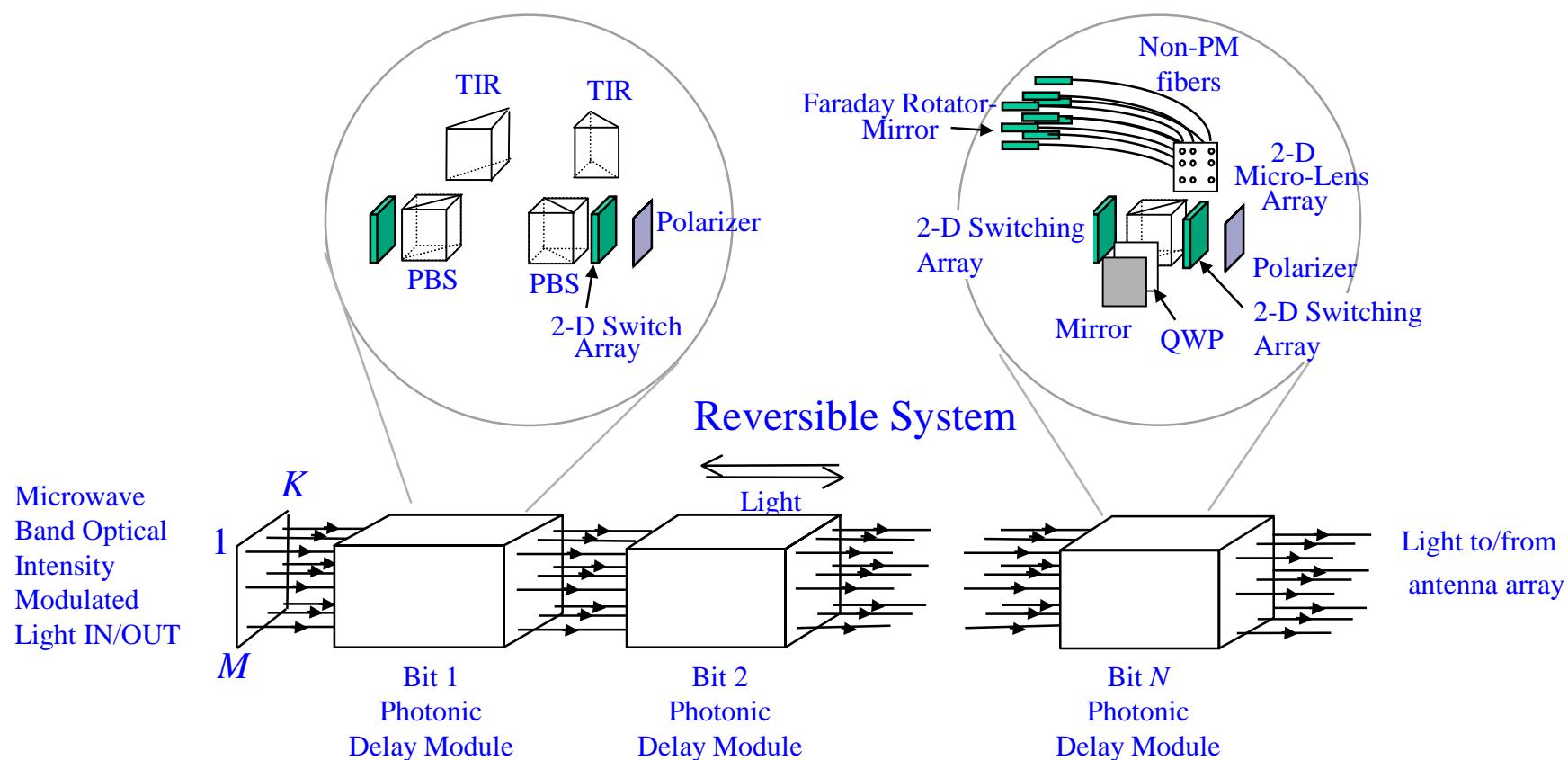


Remote Time Delay Beamformer to an Environmentally Friendlier Control Site -- Ship's Hull

Our Approach

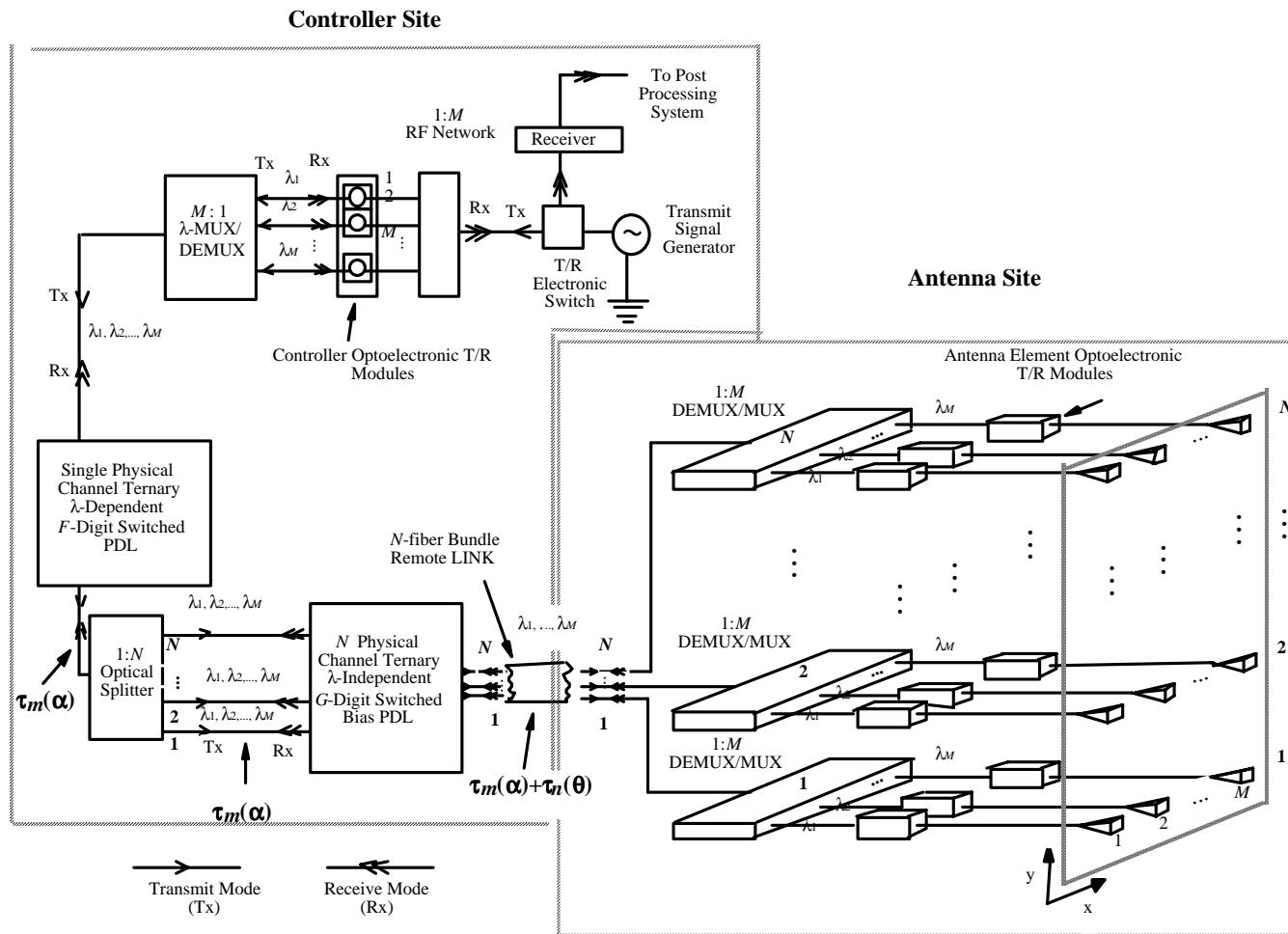
The Multichannel Reversible Binary Optical Delay Line Using

- 3-D Polarization Optics and
- High Packing Density Planar Optical Switching Arrays

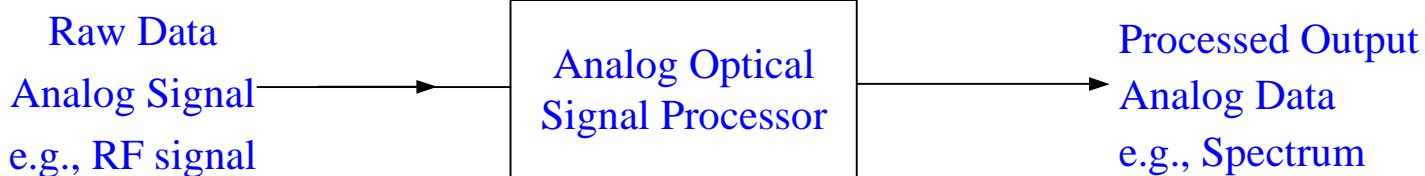


The 2-D Beamsteering Case

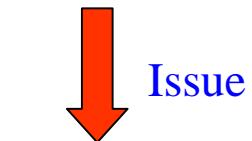
Independent 1-D Steering in the two Orthogonal Directions



Analog Optical Signal Processing



Motivation for Optics → Wide Instantaneous Bandwidth
RF Signal Processing



RF-O-RF Conversion

Dynamic Range



RFLICS



Basic Operations of Analog OSP

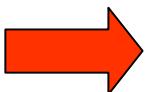
- Gain Control
- Time Delay Control
- Phase Delay Control
- Space Summation
- Time Summation

Device/Module Needs

- High Speed Variable Optical Attenuators
- High Speed Low Loss Variable Photonic Delay Lines
- High Speed Low Loss Variable Photonic Phase Shifters
- Low Loss Spatial Optical Combiners and Hardware Compressors
- High Dynamic Range Time Integrating Detectors

Wideband Signal Processing Operational Needs

- Radar Signal

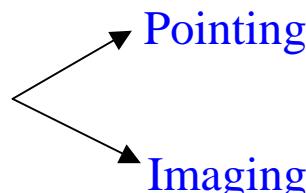


- Range-Doppler Two Dimensional Processing
- Coarse-Fine Spectrum Analysis Processing
- Correlation - Transversal Filtering
- Convolution - Spectral Filtering

- Array Signals

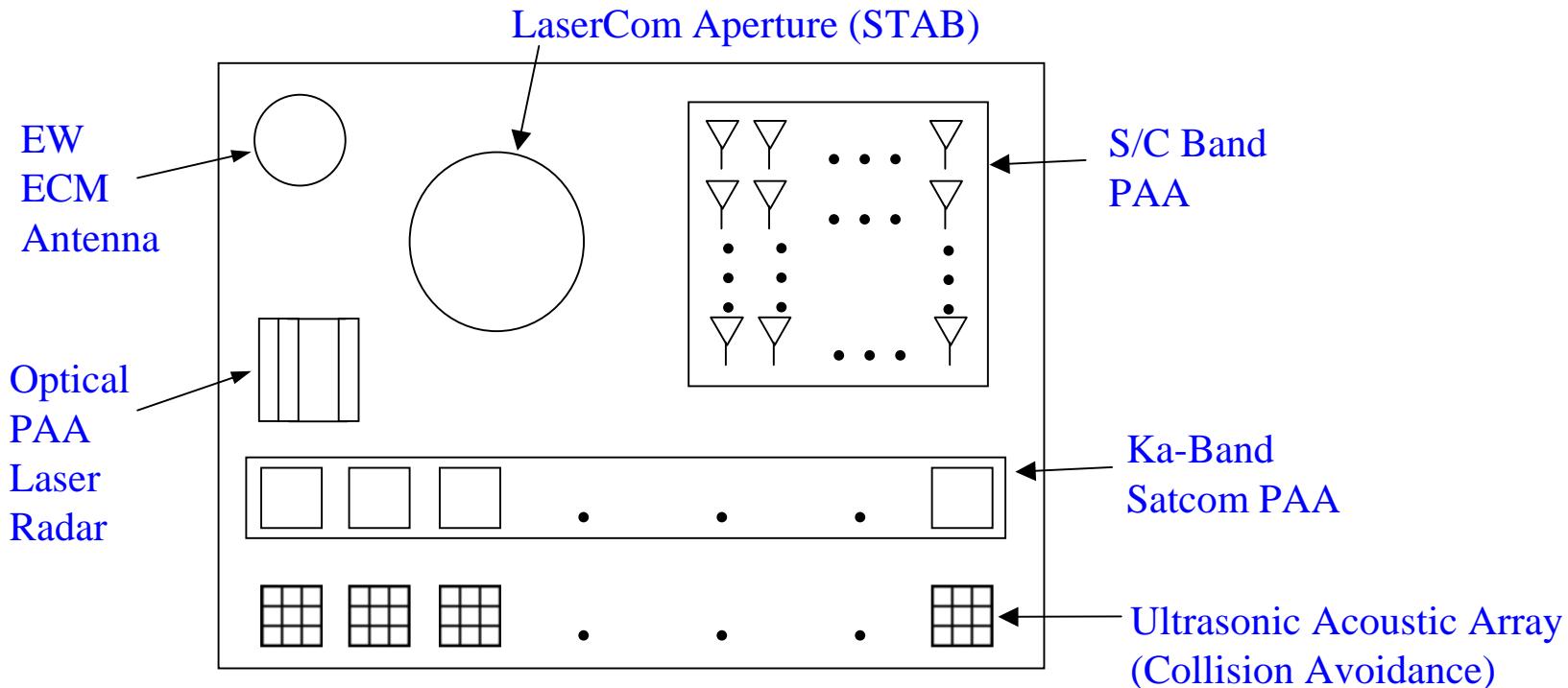


- Beamforming Systems



- Adaptive Nulling/Jamming Systems

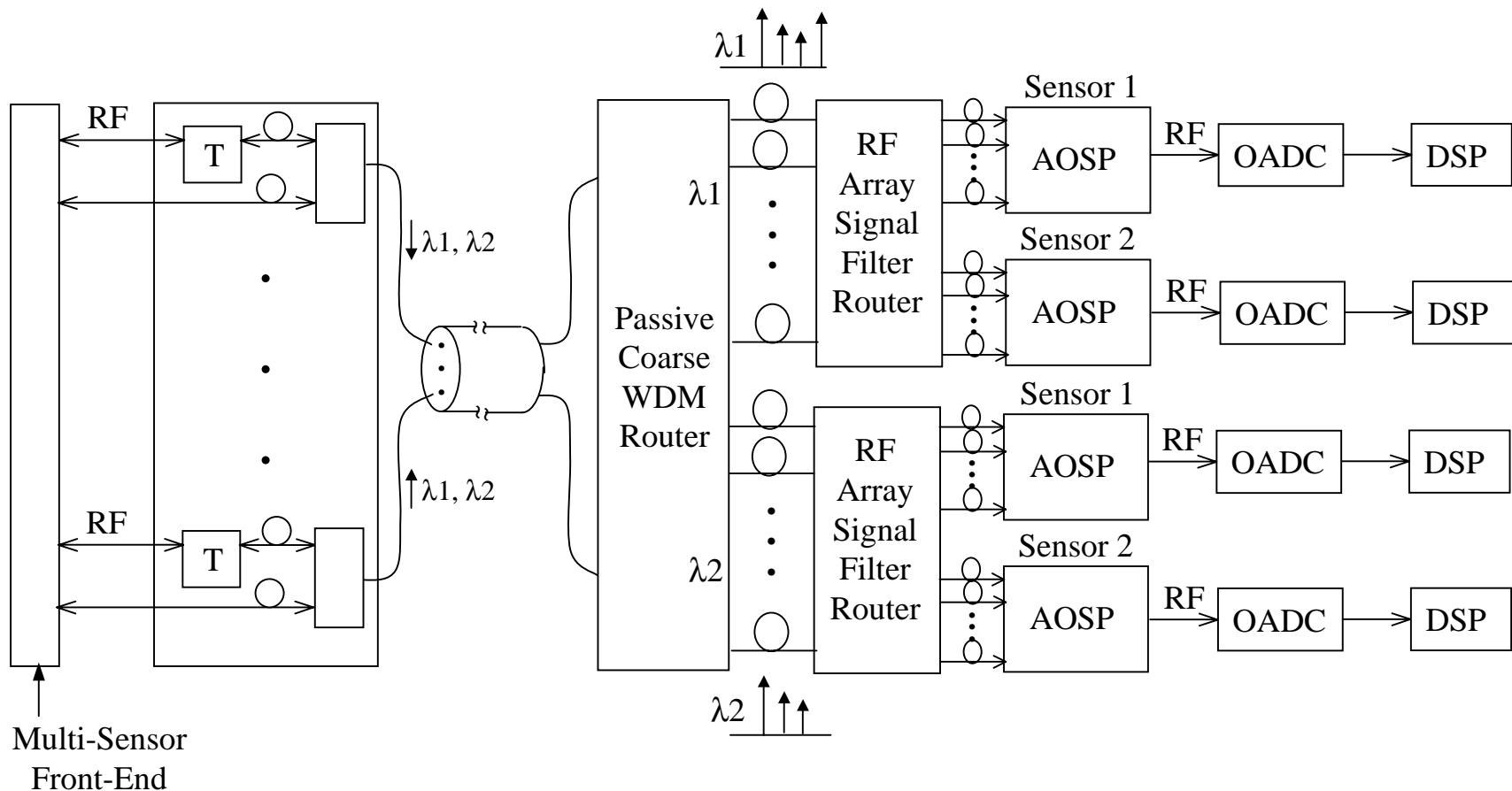
Next Generation Multi-Function Distributed Embedded FrontEnd Sensor



Sensors:

- RF
- Acoustic
- Optical

Future Sensor System Architecture



T: RF-Optical
Optical-RF Module

DSP: Digital Signal Processor

OADC: Optical Analog-to-Digital Converter